SCOPE AND METHOD OF STATISTICS.

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INTRODUCTION.

By WALTER F. WILLCOX.

It is a pleasure to welcome to the pages of these *Publications*
the writer of the following weighty article and to express my
own debt to him, a debt which began almost a quarter of a
century ago with the beginning of my work as a teacher of
statistics and has steadily deepened with the passage of the
years.   I know of hardly any writer in this field from whom
I have learned more and whose work I can commend to others
more unreservedly.   That I am not alone among Americans
in this opinion is suggested by the fact that years ago Pro-
fessor Westergaard was invited by the United States to rep-
resent the guild of European statists at the Congress of Arts
and Sciences in St. Louis and to give there an address upon
demography.   As he was unable then to accept, the present
article may be deemed his first appearance before an American
public and it seems appropriate, therefore, for me to add a
few personal words about his career.

The son of a distinguished Oriental scholar, he himself
turned first to mathematics and later to the social sciences.
In these departments his academic work was supplemented
by extended journeys in Germany, Austria, Switzerland,
France, and England, during which he studied social problems,
statistics, and insurance.   At the age of 28 he presented to
the University of Copenhagen a work on mortality outlining

and appraising recent investigations of the death rate in various classes of the population. This brought to him the University's gold medal offered as a prize for the best treatise on that topic. His work was published in German under the title, *Principles of Mortality and Morbidity*, and at the same time the author, who had already been employed for two years in the Danish Insurance Office, became a professor of social science at the University which had thus crowned his work. His book is an effort to analyze the various causes or influences, such as age, sex, marital condition, environment (urban or rural), race, religion, occupation, and diet, which affect man's death rate and to measure, or at least to point out the sound method for measuring, the effect of each influence upon mortality. Nearly twenty years later it appeared in a new edition completely rewritten and greatly enriched by the results of the author's intervening studies and those of other scholars in the same subject. For years I have found it an indispensable repository of fact and above all of argument, critical and constructive, in the wide field it covers.

Professor Westergaard's second book, appearing after an interval of eight years, grew directly out of his teaching. It is an *Outline of the Theory of Statistics*, published simultaneously in Danish and German editions and designed especially for the use of students in social science at the University of Copenhagen. Perhaps no better introduction to the present article can be found than a few words from the preface to his second main work:

Writers on the Theory of Statistics are often satisfied with developing the methods employed in special fields, like mortality, merely adding a few general remarks about the regularity of statistical phenomena and its consistency with our ideas of human freedom. This blinks the main question; namely, Under what conditions and within what limits is the regularity of statistical phenomena, "the law of large numbers," manifested? To sidestep that question has advantages, because it relieves one from entering upon a mathematical analysis; but it has also serious disadvantages, because it deprives statistics of its foundation. In following that procedure the statist cannot decide whether he has a solid basis

for his work because he does not know whether the law of large numbers is exemplified in the material before him. In the first part of the following book I have set forth the fundamental principles of the calculus of probabilities and then undertaken a task often overlooked, that of investigating whether these principles are exemplified in the results of statistical observation.

This second work of Westergaard, like the first, has been thoroughly revised and rewritten within the quarter century since it was published and is now about to appear in Danish. I sincerely hope that it may appear also in an English edition.

The present article is an epitome of the author's mature conclusions on a subject upon which American statists need to profit from the results of European scholars. The author's familiarity with the best English experience, perhaps suggested by the fact that the first edition of each of his two main works is dedicated to an English scholar and insurance expert, appears on nearly every page. He is wonderfully well informed also regarding the development of his subject from the beginning and his chapters on the history of statistics and of mortality statistics are marked by a combination of erudition and analytical power which raises them high above almost any other work and makes them a model in that field. For American scholars this is the more important because hardly one even of our scholars' libraries possesses the books needed for independent investigations in the history of statistics and yet perhaps no study provides a better thread to guide our researches past the pitfalls which trapped many former investigators and into the fruitful fields of statistical analysis.

In another respect, also, Professor Westergaard has much to teach our American statists. Those persons, mainly government officials, who are engaged in prosecuting statistical inquiries are seldom inclined by interest and training to use subtle or unusual methods of refined analysis upon the figures they have produced and thus fail to extract their full meaning. But they often have a just and sometimes an exaggerated appreciation, developed by their own sad experience, of the many errors from which their results suffer and of the uncertainty or at least the considerable margin of error in their

conclusions.   This seems to be true of nearly every official American statist since Walker and Wright.   On the other hand, such American scholars, trained in higher mathematics, as apply refined and modern methods to statistical data are, in the main, university men whose experience has seldom given them an opportunity to estimate the margin of error in official returns.   They frequently accept without question figures so wide of the truth as to be most unsafe.   For example, my own experience, including membership on a committee appointed to probe the divergencies between the figures of the Census Office and those of the Department of Agriculture, has made me sceptical of the annual returns showing acreage and yield of the staple American crops, returns now published under the more descriptive title of crop estimates.   For this reason I have not thought it safe to use them in any published discussions.   And yet elaborate theoretical structures employing the most refined methods have been built on these figures apparently without inquiry as to whether the foundation is strong enough to support the superstructure.   These two classes of investigators, the producers of statistical data and the analysts of the results, need a closer coöperation and a more intelligent sympathy with each other's work.

It is noteworthy that Professor Westergaard, whose contributions to the refinements of statistical method have been of the first importance, should close his present article with the suggestion that our first object "must be not so much to prepare refined statistical methods as to provide useful observations. . . . At present we are more in need of statistical data than of theoretical investigations. . . . We want statistical observations covering new fields and here an enormous amount of work remains to be done" (page 52). In the United States both types of work are sorely needed, but more important than either alone is a sympathetic comprehension by each group of the aims and the difficulties of the other.   In this way, and in this way alone, the new material needed can be most rapidly secured and the new methods applied only to significant material.   Such a lesson of open-eyed and sympathetic coöperation Professor Westergaard is preëminently qualified to teach.